Space Weather Technical Forecast

Issued on Sunday, 17 July 2022 at 01:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1-R2 Likely throughout. Active electron fluence continuing into the new week. Chance of G1 towards end of period due to CME impact.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate over the past 24 hour period, with X-ray flares at GOES16 peaking with an M1.1 flare from AR3057 at 16/0629UTC and an M1.4 flare from AR3055 at 6/1539UTC. These two sunspots are two of nine active regions on the solar disc at present, with almost all of this roster comprising large and mature Zurich E-groups.
Main trends in the front side sunspots were for overall growth in AR3056, 3057, 3058 and 3059, with all of this occurring in the trailing portions of the aforementioned groups apart from AR3056, which saw its leaders proliferate. The two large spot groups nearing the western solar horizon showed a more stable or slightly declining areal trend, while a newly-numbered calved off portion of AR3058 (AR3060) was an unremarkable unipolar Hsx.
The large filament that lifted off from the northwestern quadrant bifurcated and largely erupted heading north and west of the Sun-Earth line between 13/1300 and 1600UTC. This was clearly visible as a partial halo in resulting Lasco imagery, with good triangulation available from STEREO A COR2. Numerous assessments of this ejecta have been carried out as further imagery has become available, and have crystallised into a most likely arrival time around the turn of the UTC day Tuesday 19 July into Wednesday 20 July. Another large filament that lifted from the southwest quadrant later in the day of 16 July has still to be analysed for a Earth-bound CME component.
One CME is therefore thought likely to be en route, that from the 15/1300UTC filament and is considered to be due around 19/2359UTC.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by ACE and DSCOVR at L1, has been elevated over the past 24 hours, likely the result of a now slightly waning coronal hole high speed stream, possibly that emanating from CH99/+.
The solar wind speed was elevated throughout with a declining trend and is now around 450 km/s. The solar wind density was mostly near average low figures ppcc The IMF was weak throughout the period, with a peak of 7nT, but with a persistent anti-aligned character (versus the Earth's field), ranging from -7 to very brief peaks of +3nT. The phi angle was positive (away from the sun) throughout.
The net result of the above solar wind measures was Quiet to Unsettled, with a provisional peak Kp of 3- recorded at 16/06-09UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at Background levels.
The high energy electron flux (greater than 2 MeV) increased to reach to peak at High flux of 3340pfu at 16/2045UTC. The corresponding 24-hour integrated electron fluence exceeded the Active (1e8 integrated pfu) threshold during the UTC evening o 16 July with a rising trend and an observed value at 17/0000UTC of 1.37e8 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate, with a daily Slight Chance of X-class flares. Two of the current large sunspots should leave the Earth-facing side into the new week, resulting in a slight reduction in flare probability. Arriving bright flux over the eastern limb may compensate for any loss, however.

Solar Wind / Geomagnetic Activity: The 15/1300UTC filament CME is due towards the end of the current forecast period, around the turn of the UTC day Tuesday 19 into Wednesday 20 July. Another large filament that lifted from the southwest quadrant later in the day of 16 July has still to be analysed for a Earth-bound CME component. No other CMEs feature.
Two fast wind streams may feature in the forecast: firstly an exit from the long-peaked current CH99/+ high speed stream; and secondly minor influence from CH03/- on day three (Tuesday 19 July).
All considered, activity should continue Quiet, but increase to a (probably protracted) Chance of G1 on Tuesday 19 July from the combined effect of the 15 July CME mentioned above, and any high speed stream from CH03. The slow speed of the assessed CME may result in the risk of G1 extending through midweek UTC before easing.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at Background levels, but with a daily Slight Chance of S1 or greater due to the presence of large sunspot regions in the west or near centre-disc.
The high energy electron flux (greater than 2 MeV) is expected to remain at moderate to high levels over the coming days. Fluence levels starting above the Active (1e8 integrated pfu) fluence level may drift back below the threshold on days two and three (18 and 19 July) as indicated by the Met Office REF model which appears to be giving sensible guidance.

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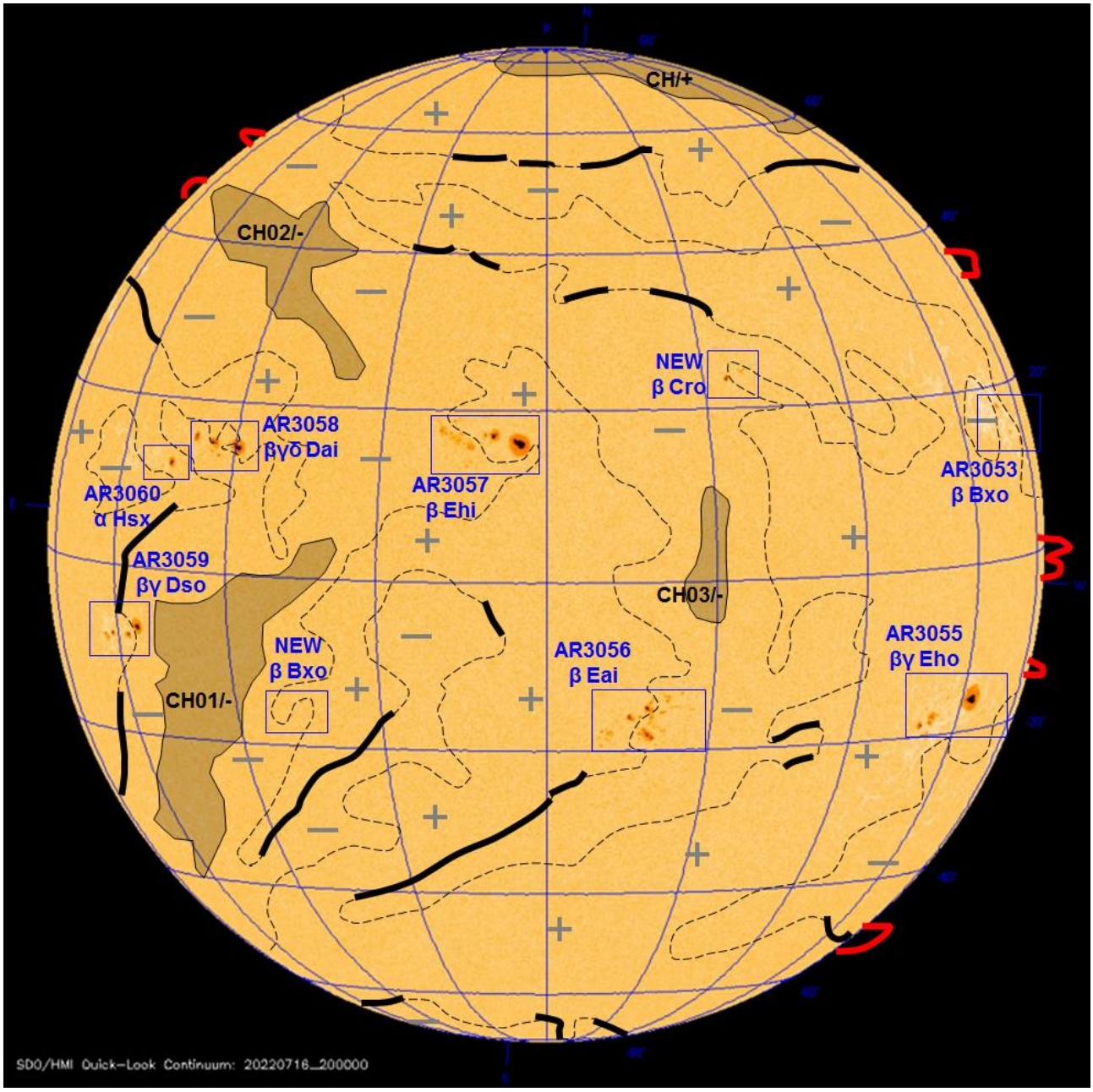
Figure 1. Solar Analysis Valid 2000UTC, 16 July 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The 15/1300UTC filament CME is due to impact Earth towards the end of the current forecast period, around the turn of the UTC day Tuesday 19 into Wednesday 20 July. No other CMEs feature. In addition two fast wind streams feature in the forecast: firstly an exit from the long-peaked current CH99/+ high speed stream; and secondly minor influence from CH03/- on day three (Tuesday 19 July). The second of these features is relatively ill-defined on the current disc, but its appearance is a reasonable analogue with last pass and it is expected to be the minor player given the transients due around the same time.

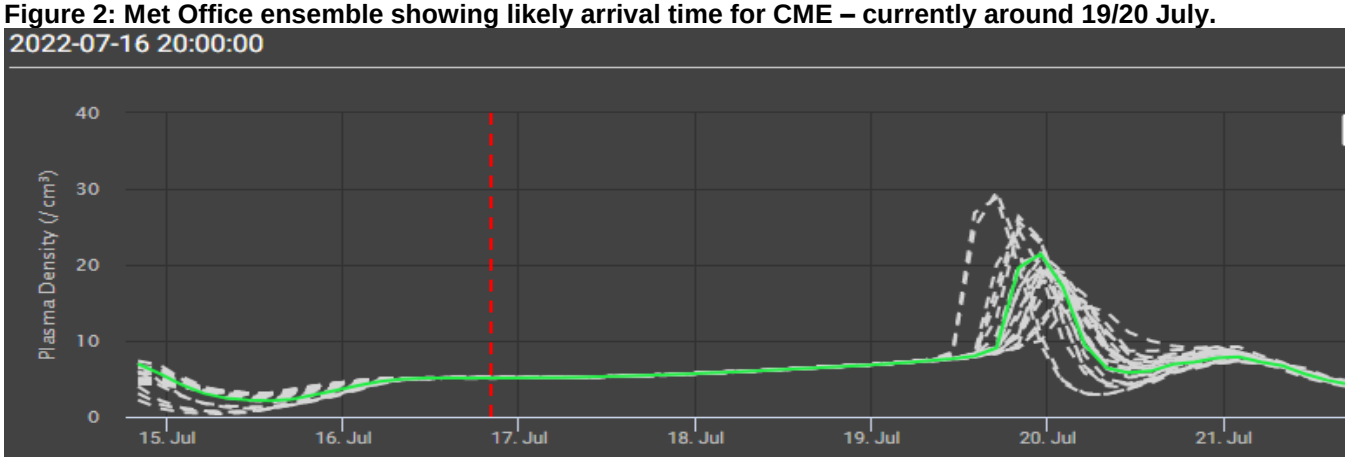
Geomagnetic activity is likely to remain at Quiet levels, but increase Unsettled to Active (probably protracted) with a Chance of G1 on Tuesday 19 July from the combined effect of the 15 July CME mentioned above, and any high speed stream from CH03. The slow speed of the assessed CME may result in the risk of G1 extending through midweek UTC before easing.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	40	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
160209	Partial	Filament eruption	NW Quadrant	396km/s	Turn of UTC day Tuesday 19 into Wednesday 20 July	Partial halo with main ejecta to West

Figure 2: Met Office ensemble showing likely arrival time for CME – currently around 19/20 July.



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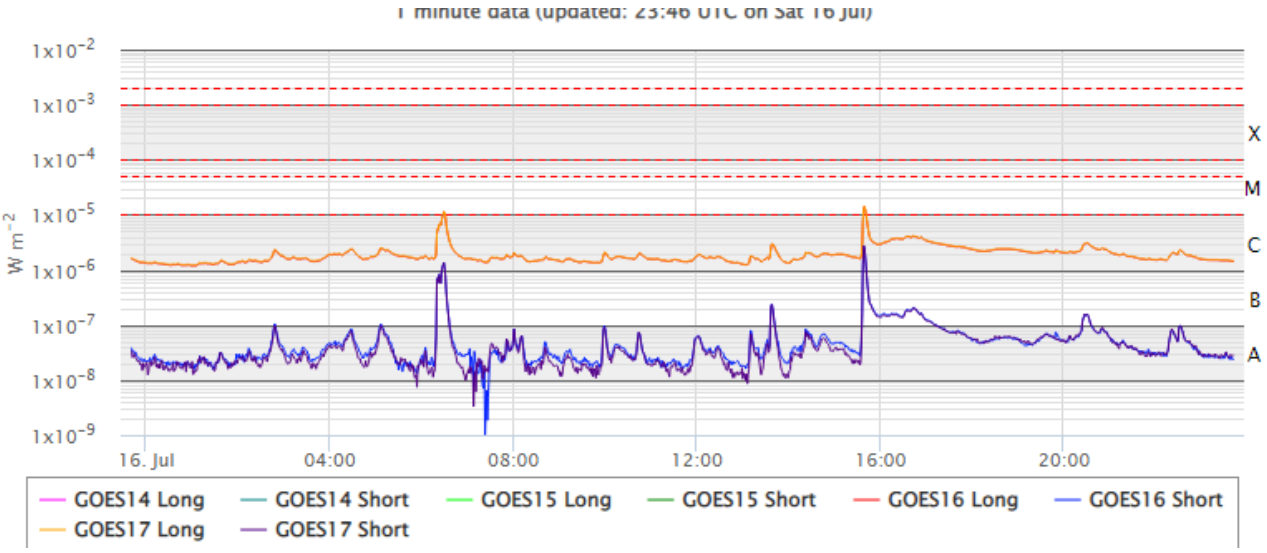
Radio Blackouts - X-Ray Flares:
Solar activity is Moderate and further M-class events are Likely each day of this period given the number of large, complex sunspot regions. Considering the overall balance of sunspot groups, two regions are due to leave the disc on Days 2 and 3 (18-19 July). This results in a slight decrease in the probability of flaring towards the end of the period. Arriving bright flux over the eastern limb may compensate for any loss, however this will be assessed as and when this region arrives over the northeastern solar horizon.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	65	65	50	40
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: X-ray flare plot at GEO with numerous C-class flares and a couple of M-class flares in the past 24 hours.



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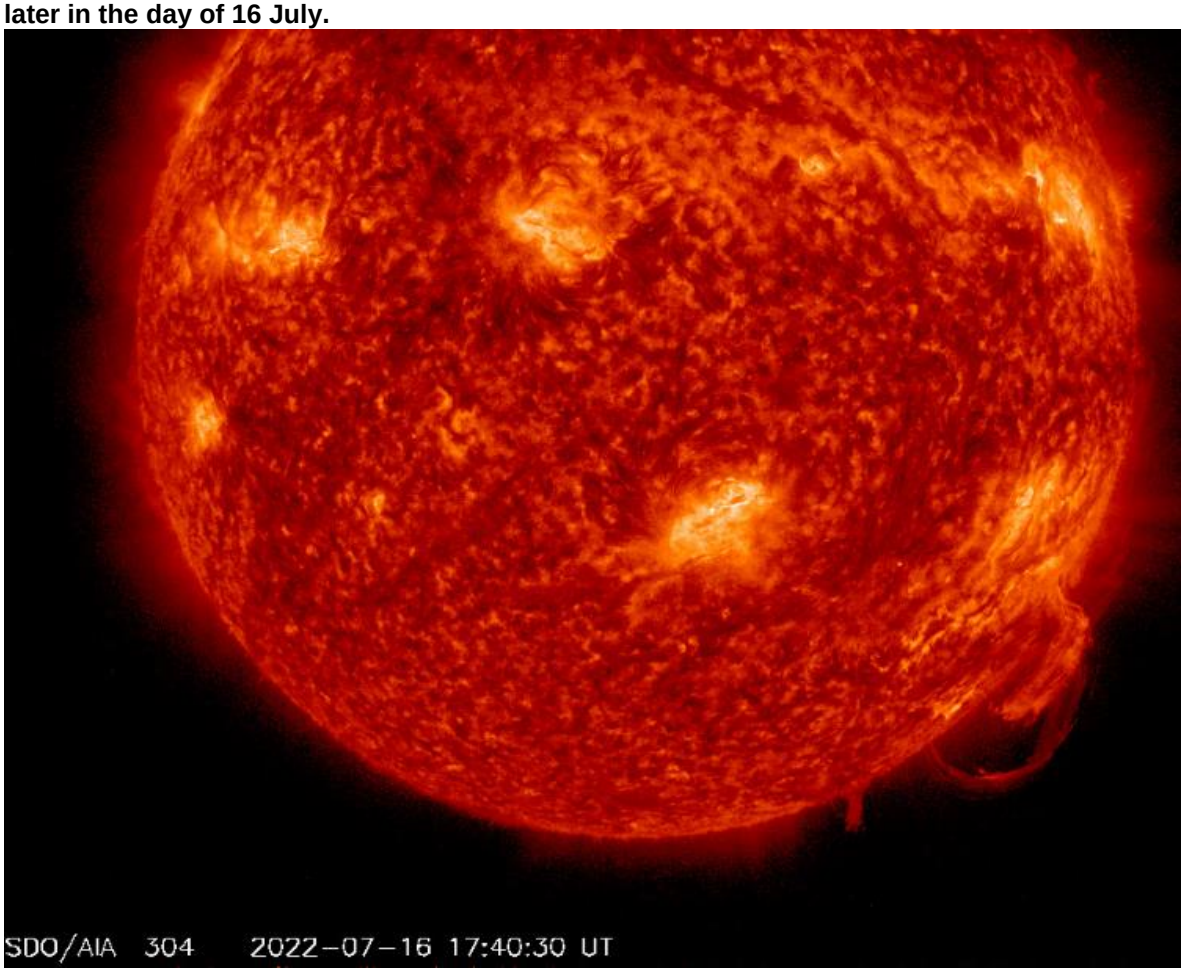
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is currently at Background levels. Owing to the complexity of the current disc, and in particular several large regions in the west or near centre-disc, there is a daily Slight Chance of S1 or greater occurring. Sub-S1 events of the past week were tied to a feature (Ex-3047) that is now long since passed its peak geoeffective location (being several days onto the far side), and none of the present front-side sunspots have any history of any proton enhancement so far.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO AIA-304 imagery with the filament lifting from the southwest limb of the visible disc later in the day of 16 July.



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High Energy Electrons Event (≥ 2MeV):
The diurnal variation in high energy electron flux (greater than 2MeV) is currently peaking at High levels, with an overnight UTC upward response seen in flux as geomagnetic activity from CH99/+ has eased. This elevated solar wind speed ought to establish a new stable oscillation over the current UTC weekend as it eases further. Persistence from the last rotation is offering a reasonable match for current observations, adding credence to the suggested forecast for fluence. An anticipated CME arrival from the 15/1300UTC filament eruption CME ill result in compression or redistribution of electrons and is largely expected to be around midweek, and this will lower levels of electron activity, as indicated by the lowering probabilities in the forecast table above, and also reflected in the output from the Met Office REF model.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	80	70	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	5	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output showing high levels currently.

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